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ABSTRACT

The number of women pursuing the sciences has improved since the 1970's. However, the attrition rate of females from college and graduate study of science still exceeds that of their male peers. This project uses qualitative methodology to explore the supports and coping methods which have enabled a selected group of female biologists to complete their training and to pursue an academic career. Twenty women were each interviewed once to collect educational and career histories, and to discuss sources of support and discouragements, coping methods and suggestions for improving the situation. Six subjects are new faculty, six are within two years of the tenure decision, and eight are well-established researchers. Family, peers, teachers, research advisors, and role models were cited as sources of support. Other sustaining influences are self-esteem and the rewards of teaching and experimental research. Sources of difficulty include the conflict of personal life and career, gender discrimination, the current funding crisis and the inherent frustrations of scientific research. (Author)

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EDUCATIONAL HISTORIES OF A SELECTED GROUP OF FEMALE ACADEMIC BIOLOGISTS

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ABSTRACT

The number of women pursuing the sciences has improved since the 1970's. However, the attrition rate of females from college and graduate study of science still exceeds that of their male peers.

This project uses qualitative methodology to explore the supports and coping methods which have enables a selected group of female biologists to complete their training and to pursue an academic career. Twenty women were each interviewed once to collect educational and career histories, and to discuss sources of support and discouragements, coping methods and suggestions for improving the situation. Six subjects are new faculty, six are within two years of the tenure decision, and eight are well-established researchers.

Family, peers, teachers, research advisors and role models were cited as sources of support. Other sustaining influences are self-esteem and the rewards of teaching and experimental research. Sources of difficulty include the conflict of personal life and career, gender discrimination, the current funding crisis and the inherent frustrations of scientific research.

INTRODUCTION

Events of the past few decades have removed many of the formal barriers facing a woman interested in a science career. However, women are still under-represented among those entering all but the social sciences (National Science Foundation (NSF), 1992). This may be an indicator that opportunities are still inequitable.

Much of the current research on gender equity has focussed on creating and maintaining an interest in science and mathematics in school-aged girls (Oakes, 1990; Jones & Wheatley, 1988). In the field of biology, the main problem is not a lack of interest, but a lack of continuation during or after college. This occurs in spite of the higher grades which women earn in science majors (NSF, 1992; DeBoer, 1984).

This study focusses on professional education and early career formation. Data from both the National Science

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Foundation's 1992 study and Widnall's 1988 article indicate that attrition rates of women still exceed those of men at this late stage. The two years which I spent in a Ph.D. program in biology brought to my attention the tenuous and potentially isolated positions occupied by graduate students and young researchers in this field. This inspired my interest in the strategies, supports and abilities which have enabled others to survive and succeed as academic biologists.

SAMPLE

This study involved interviewing twenty women who have become academic biologists. Success is defined as having an academic position and conducting biological research. The chosen definition was my original career goal, and is not meant to imply that any other outcome is unsuccessful. The subjects are divided into three groups: new faculty within two years of receiving a tenure-track appointment, faculty who are up for or have just received tenure, and established faculty who are at least six years post-tenure. There are six new faculty, ages 35 to 40; six tenure-decision faculty, ages 39 to 45; and eight women in the established faculty group' with an age range of 45 to 78. The subjects were identified by networking: through the suggestions of advisors, colleagues, or other subjects.

METHODS

Each subject was interviewed once, and the interview was audio-taped. Each subject was asked semi-directive questions, so that she would reflect on what she believes to be important factors in her educational and career history. The questions address the subject's interactions with peers and authority figures, any difficulties she might have had, her coping strategies, her view of self as a scientist, and what she would change in science education. Each interview transcript was submitted to the subject for corrections and approval. Identifying names and fields removed from the transcripts to preserve anonymity. The transcripts were then coded, and examined individually and in groups for themes.

RESULTS

Sustaining Factors

The main sustaining factors for this group of women are personal human support networks, strong self-esteem and independence, and the rewards inherent in scientific research and in teaching young scientists. Serendipity also plays a role in some cases, in that some of the women attribute the

choosing of a good advisor to luck.

Support networks include parents, high school and college faculty, spouses, advisors, laboratory supervisors, role models, and peers. Several women repeatedly mentioned the importance of support during the interview: "...that sort of sustained me over some of these periods, when I'm sure I would have quit, had I not either been married, or had strong friends, or had strong advisors. There was always someone that sort of stepped in, right at a time that I was kind of...throwing up my hands." (018) "There are certainly women that I've come to admire enormously, but more of them are of the same generation that I am. It's a lateral sort of thing. And we did mentor each other. There's no question of that." (015) "I think the thing that supported me the most in getting through was my family. And they helped me through." (022)

Some women spoke of the lack of a support network, and the possible effect that this had on their careers. "But I have often felt like, if I'd had more support, I could have done more. I could have done better." (023) " ...usually when you begin publishing in a field, your name is co-author with the senior person who is in that field, and that is your introduction. And I have felt that [because of the departure of her post-doctoral advisor] it's taken me about twice as long, or more, than equivalently talent people to break into the field." (006)

Other women related infrequent support, or did not speak of it as a factor which related to their success. Many of these women showed signs of independence, and a strong self esteem. Indepedence is evident in the descriptions of coping methods: obtaining advice and dealing with problems directly.

> ...It just occurred to me, that I needed my own money right away. And although I had offers from my chairman to help me out, I sensed that the respect that I needed would come from independence, financially, among other things. And if things didn't go right scientifically, that was my only out. So I immediately spent three months writing all the grants I needed to write, and became independently funded to a fairly hefty degree (017).

Self esteem is also evident in descriptions of personal success. "...I have decided what is successful for me. And I certainly think that I have achieved most of what I had set out to do." (006) "I'm doing what I want to do. And getting paid for my hobby. How much more successful can you be?" (011)

There were a few cases where a woman also spoke of having limited support, and experienced at least one period of low self-esteem. "There were several cases during my graduate career, when I was harassed, sexually. Which had an undermining effect on my self-esteem; and given that my self-esteem was minimal during graduate school anyway, it didn't serve any positive purposes at all." (017) "I don't see myself as a role model for a young woman who wants to go into (her field). I don't feel like I have anything to offer them. " (023) This same woman also told me she did not believe herself to be successful.

The occurrence of low self esteem is a concern because of the frustrations inherent in laboratory science. "...science doesn't work eighty or ninety percent of the time; and so you're miserable [in graduate school], because that's all you do, and it doesn't work." (021) When asked about coping with fights with advisors or failed experiments, one women responded: "Oh, the standard life?" (022) "I developed a philosophy for experiments not working, and for grants: the suffering index. You suffer and suffer and suffer, and then all of a sudden things start working." (010)

In spite of these descriptions of frustrations, the love of science is almost palpable in all of these women. In answering 'What is the essence of science?', almost all of the subjects became animated. "What fun science is. Even though all the pain and heartache and everything. That one moment when something falls together, it's like Christmas. New Years. All rolled up into one." (010) "Knowing more tomorrow than I did today. And that's fun, and that's amazing." In the face of the inherent frustrations and other difficulties, these women seem to have been sustained by a love of science and the desire to answer their research questions.

In addition to the rewards of scientific research, these women also cited the pleasures of teaching young scientists. "What fun it is too, to see younger scientists develop. It's marvelous to watch.": (010) "...I have wonderful graduate students, people want to work with me, and they've gone off to do successful things--which is another--for me, a major measure of success is how well my students do." (006)

The subjects of this study appear to have been sustained in their pursuits by varying combinations of self-esteem, the advice, example and support of one or people, and the rewards of research and teaching in science.

Coping Strategies

To uncover coping strategies, I asked the subjects how they responded to arguments with advisors, and to failed experiments. The answers varied from direct action, to burying oneself in lab work. Direct action was seen as the most effective method. "So, I'd say throwing up one's hands in dismay is probably worthwhile doing for the first five minutes, and then the best antidote is action. And action that is decisive and directed." (017) Direct action consists of confronting problems head-on. "..in the first case we just talked about things until they were resolved, and in the second case I just tried other approaches to the experiment." (013)

Using direct action as a coping method requires self-confidence. One must be able to defend one's point of view, and not see failed experiments as due to personal worthlessness. "...you have to be willing to chance a little bit [to succeed in a creative endeavor]. And it does require a certain feeling that you won't be diminished as a person, for having made a mistake." (015) "Talking with other graduate students and post-doctoral trainees helped me to realize failure is not personal. We all get to experience it." (012) Therefore, some subjects did not start to use this method until the post-doctoral period, or later.

Another popular method is talking troubles over with peers and other supporters, which requires the availability of such. This can be a particular problem in early graduate school. "This feeling that there was no support network. You were just kind of hanging out there." (022) Peers and advisors provide good support, because they have experience with the system, and can offer practical advice and validation. They can also advise and network once the student has started her own lab. "When I for instance had a terrible fight with the person at (her first job): the next day I called 'fifty of my closest friends', looking for jobs anywhere in the country." (017)

Detaching from science is another coping method employed by some of the women. "If I had a particularly bad day, I would go play racquetball; and hit the ball and pretend it was my major professor...And after I met my husband, I still had sports, but I also had someone to complain to." (022) "...in grad. school, my usual reaction was to sort of disengage, and bury my head in a book or something." (021)

The last coping method, and perhaps least productive one, is to bury oneself in laboratory work. "As a graduate

student, I was so mixed up, that half of the time I would just work through the night. That never really produced the appropriate amount of awesome data at the other end that I thought it would." (017) Most of the women who used this method did so only during graduate school.

Subject-Suggested Changes

During the course of the interviews, the subjects suggested changes which would have improved their own experiences, or would serve as an aid to women in science. In the field of science education, these suggestions include: stop inhibiting girls from pursuing science and mathematics; provide more good female role models; increase the amount of science education; and increase hands-on and thinking, while decreasing rote learning in both grade school and college science courses.

One major concern regarding graduate education is the improvement of the mentorring experience. Suggestions were made for increasing the likelihood of a good match of personality and interests. The preferred method would involve the requirement that each student complete a rotation through three different laboratories before choosing an advisor. One woman also suggested, half in fun: "And I think we ought to mark those people who are jerks. Not let them have students anymore." (012)

The other graduate school concerns were communication skills, and social support. "...a village culture for young scientists [is] very good. Where there are groups of people, either peers or mentors, or mentor-sort of supporting peer groups and so on, that allow people to talk about science... [A place where] it's OK to fail, and to go on and to learn from that. Not just to fail and to learn how awful you feel when you fail, but to fail and to be able to back off and say, 'OK, how could I have done it differently?'" (015) The concern about social environment is of particular interest, since the majority of the subjects recalled first year difficulties, while adjusting to one aspect or another of graduate school.

In addition to the suggestions regarding formal education, two third of the new and the peri-tenure subjects spoke of needed changes in science and society. These changes are viewed as necessary, if women are going to be able to establish a comfortable balance between a family and a scientific career. The problems behind these changes may be related to the attrition of women from the later stages of training. In particular, two of the senior women asked me

about the disappearance of women after post-doctoral training. "...why (do) we see them do so terrifically well as students, ...and the ones who go on to post-doc. do terrifically well as post-docs., and then somehow the pool of available women seems to shrink at that point. And I don't know where the black hole is, that they fall into." (011)

Some of the younger women offered theories to explain this late attrition of women from academic science. These women have witnessed the departure of female students and peers, and related such departures to the current funding crisis and to the perceived difficulty of managing a scientific career along with a family in the United States. One tenure-time woman with small children said, "My being a role model in this sense is actually not entirely positive; because there are people who see me, and they say to me, 'You know, I'm not going to do what you're doing. That's too hard.' And it <u>is</u> hard. [emphasis hers]" (019) "...if scientists can't get--get money, and institutions are not going to hire you without grants, it's not a very rosy picture to paint to students coming along the line." (012)

Many of the women in this project spoke of difficulty in making decisions regarding having a family and a career. "...there has been a bias against women having private lives in science, that I think is very detrimental. I'm thirty-nine; I'm terrified to have a child. ...I haven't had any encouragement that it would be OK to have one and still be an effective scientist." In addition to the potential effects upon reputation, there is a time conflict inherent in having children during a scientific career. The current system of tenure requires that scientists be most productive during a time when many women would choose to have children. Judging by the demographics of this sample, the tenure decisions currently occurs around the age of forty. This leaves women with the choice of remaining childless, juggling research with raising young children, or taking the risks of delaying maternity.

A few women suggested the academic career be changed to better allow for raising of small children. However, one woman warned, "What I don't like about this idea (more time to tenure for women) is that it suggests that women should continue to provide most of the care-giving and nurturing required in a family situation." (016)

The women in this study did not restrict their suggestions to the creation of equitable education experiences. Subjects also proposed improvements in advisor selection processes and the creation of a supportive

environment in graduate school. In addition, the current funding crisis and the potential conflict between reproduction and tenure review were indicated as situations which might cause a young woman to select a non-academic career.

CONCLUSIONS

Role models have been important to several of the women in this study. However, more women suggested an increase in laboratory teaching and a decrease in rote science teaching. Hands-on science experience is considered important for retaining the interest of girls (Jones & Wheatley, 1988; Oakes, 1990). Many of the women cited the first exposure to actual laboratory research as the factor which caused them to choose a research career. "...when I actually did research, that was it." (023)

> I went to an old high school where there were terrible fire hazards, but we were allowed to do all sorts of experiments in the science labs, ones that we thought of doing. Some of which, of course, were just dreadful. [laughs] This gave me the idea that you could play at this stuff, and a number of us did [emphasis hers] (015).

Many of the women in this project associate their decision to pursue science with real research experience, as do the eminent male scientists in Roe's study (1952).

The import of teachers actions and expectations on students and girls is relatively well studied (Jones & Wheatley, 1988; Oakes, 1990). The support and role modelling which parents provide their daughter has been positively tied to the likelihood that this daughter will choose a 'non-traditional' career (Betz & Fitzgerald, 1987; Oakes, 1990). However, the literature has made little mention of the extensive peer support cited by several of women in this study. Of particular interest is the development of peer relationships in graduate school, which serve as significant sources of advice, support; and later serve as networking contacts.

The influence of supportive relationships is of interest in light of the comparatively lower self-confidence of the younger women in this study, and also the mention of self-esteem battering in graduate school by three of those women. Such reports imply that there may be insufficient support available for graduate students. As one woman stated, isolation and excessive pressure do not provide a good environment for risk taking and learning from mistakes.

Encouraging the development of peer groups could help such situation, and might also ease the transition into graduate school. Peer groups have been cited in this study for encouragement, positive competition, problem solving, aid in job-finding, lateral role-modelling, and the prevention of at least one woman from quitting science.

Another area which requires some attention is the advising of graduate students, and perhaps even of young faculty. Since the graduate advisor is a student's main source of training and feedback, the choice of an advisor is particularly important. Mandatory lab rotations increase the number of investigators that a student experiences, but do not guarantee finding a good advisor. Perhaps intra-departmental meetings with senior graduate students would help new students choose the best possible rotation candidates.

In addition to the usual graduate and post-doctoral advising system, some schools have a system of mentorring for junior faculty, to help them get started in teaching, departmental policies, and the business and networking end of science. Such a system appears valuable, since several new and peri-tenure subjects mentioned having some difficulty with these topics during the first year as faculty. However, such systems are currently rare, and in some cases are not being put to practice.

Finally, the apparent lifestyle of women in science is having an impact on adult students. The majority of the women who switched out of a technical major in a college study claimed that they did so at least in part as a rejection of the lifestyle associated with their former major (Hewitt & Seymour, 1991). The women in this study have also reported that such decisions are also being made by their female peers and students. While these latter women are not necessarily rejecting science, they are leaving the academic track. One of the problems which concern young female scientists is common to professional women: the difficulty inherent in juggling a career and a family (Betz & Fitzgerald, 1987; Astin, 1969). However, the long laboratory hours and the late age of tenure review as a result of post-doctoral study make science appear particularly inhospitable to some women. Unless this situation is alleviated, academic science will not be an attractive option for those who wish to be active parents.

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